GROUND-STATE D MESONS (D^+, D^0, D_s^+)

New in the 2006 Review:

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(Some papers contribute to more than one category—for example, Cabibbo allowed and Dalitz plot—but only one entry is given per paper.)

Major improvements, brought on by better data and recommendations by Patricia Burchat and David Asner:

(1) There are now good Dalitz-plot analyses of several 3-body decays of D mesons, such as

$$D^0 \to K_S^0 \pi^+ \pi^- \to K_S^0\, \rho^0,\ K^{*-}\pi^+,\ \text{etc.}$$

(BABAR uses 17 amplitudes to fit this decay!) Due to interference effects, the sums of the sub-mode branching fractions don't add to one. Where we have them, we use the "fit fractions" obtained from such analyses, and no longer use older sub-mode fractions obtained from invariant-mass projections. This is rather like the 1960's, when resonances were often first seen in total cross sections and invariant-mass plots. With better data, partial-wave and Dalitz-plot analyses made these first results obsolete.

This change means that the Summary Table no longer gives a $D^0 \to K^{*-}\pi^+$ branching fraction, but instead gives the $D^0 \to K^{*-}\pi^+ \to K_S^0\pi^+\pi^-$ fraction as a sub-mode of $D^0 \to K_S^0\pi^+\pi^-$, and the $D^0 \to K^{*-}\pi^+ \to K^-\pi^0\pi^+$ fraction as a sub-mode of $D^0 \to K^-\pi^0\pi^+$.

This change and the next one required a lot of mark-up of the Data Listings and a lot of work by Piotr.

(2) In D decays with a K_S^0, the assumption used to be that the K_S^0 was born as the Cabibbo-favored $\bar{K}^0$ rather than as the doubly Cabibbo-suppressed K^0. However, interference between the two amplitudes can invalidate this assumption by a few percent. Thus, for all the well-measured branching fractions with a K_S^0, which we used to list as $\bar{K}^0$ modes, we now list as K_S^0 modes (dividing the old $\bar{K}^0$ branching fractions by two).

(3) A note on "Dalitz-Plot Analysis Formalism," writtten by David Asner, was added in the Data Listings. This accompanies the note, "Review of Charm Dalitz-Plot Analyses," also written by Asner, which discusses what is presently known experimentally.

DALITZ PLOT ANALYSIS FORMALISM

Written January 2006 by D. Asner (Carleton University)

Introduction: Weak nonleptonic decays of D and B mesons are expected to proceed dominantly through resonant two-body decays [1]; see Ref. [2] for a review of resonance phenomenology. The amplitudes are typically calculated with the Dalitz-plot analysis technique [3], which uses the minimum number of independent observable quantities. For three-body decays of a spin-0 particle to all pseudo-scalar final states, D or $B \to abc$, the decay rate [4] is

$$\Gamma = \frac{1}{(2\pi)^3 32\sqrt{s^3}} \left|\mathcal{M}\right|^2 dm_{ab}^2\, dm_{bc}^2 \,, \tag{1}$$

where m_{ij} is the invariant mass of particles i and j. The coefficient of the amplitude includes all kinematic factors, and $\left|\mathcal{M}\right|^2$ contains the dynamics. The scatter plot in m_{ab}^2 versus m_{bc}^2 is the Dalitz plot. If $\left|\mathcal{M}\right|^2$ is constant, the kinematically allowed region of the plot will be populated uniformly with events. Any variation in the population over the Dalitz plot is due to dynamical rather than kinematical effects. It is straightforward to extend the formalism beyond three-body final states. For N-body final states with only spin-0 particles, phase space has dimension $3N-7$. Other decays of interest include one vector particle or a fermion/anti-fermion pair (*e.g.*, $B \to D^*\pi\pi$, $B \to \overline{\Lambda}_c p\pi$, $B \to K\ell\ell$) in the final state. For the first case, phase space has dimension $3N-5$, and for the latter two the dimension is $3N-4$.

Formalism: The amplitude for the process, $R \to rc, r \to ab$ where R is a D or B, r is an intermediate resonance, and a, b, c are pseudo-scalars, is given by

$$\begin{aligned}\mathcal{M}_r(J,L,l,m_{ab},m_{bc}) &= \sum_\lambda \left\langle ab|r_\lambda\right\rangle T_r(m_{ab}) \left\langle cr_\lambda|R_J\right\rangle \qquad (2)\\ &= Z(J,L,l,\vec{p},\vec{q}) B_L^R(|\vec{p}|) B_L^r(|\vec{q}|) T_r(m_{ab})\,.\end{aligned}$$

The sum is over the helicity states λ of r, J is the total angular momentum of R (for D and B decays, J=0), L is the orbital angular momentum between r and c, l is the orbital angular